

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 08-304448

(43)Date of publication of application : 22.11.1996

(51)Int.Cl.

G01P 15/12

G01L 1/16

G01P 21/00

(21)Application number : 07-113338

(71)Applicant : NIKON CORP

(22)Date of filing : 11.05.1995

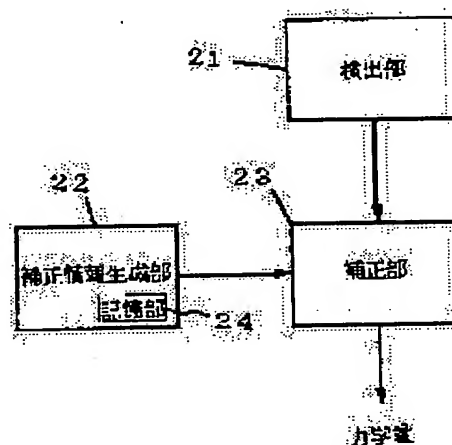
(72)Inventor : HARA SHINYA
OKAZAKI MITSUHIRO

(54) APPARATUS AND METHOD FOR DETECTION OF DYNAMIC AMOUNT

(57)Abstract:

PURPOSE: To simply generate correction information and to enhance the accuracy of a detection by a method wherein dynamic amounts in mutually opposite directions are given to one detection axis of an object provided with a detection means, dynamic amounts in one direction are given respectively to other two axes and the correction information is generated on the basis of their detection results.

CONSTITUTION: Before an actual acceleration is detected, two dynamic amounts in opposite directions are given in the X-axis direction and one each of dynamic amounts are given respectively in the Y-direction and the Z-direction regarding four positions of an object provided with a dynamic amount detector, and they are detected by a detection part 21. Then, on the basis of detected dynamic amounts, a correction-information generation part 22 computes a detection sensitivity factor and DC component values in three axes so as to be stored in a storage part 24 as correction information. Then, actual dynamic amounts are detected. That is to say, a correction part 23 receives respective voltage values, in the three axes, which are first output from the detection part 21, and it computes and finds dynamic amounts which have corrected interference components in the respective axes on the basis of the voltage values, on the basis of the detection sensitivity factor of the correction information which is found in the generation part 22 in advance so as to be stored in the storage part 24 and on the basis of the DC component values.



LEGAL STATUS

[Date of request for examination] 13.02.2002

[Date of sending the examiner's decision of rejection] 01.04.2003

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

Copyright (C); 1998,2003 Japan Patent Office

* NOTICES *

JPO and NCIP are not responsible for any damages caused by the use of this translation.

- 1.This document has been translated by computer. So the translation may not reflect the original precisely.
- 2.*** shows the word which can not be translated.
- 3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1] A detection means to detect the amount of dynamics which has two or more detection shafts and acts on each detection shaft orientations. A storage means to memorize the amendment information for amending the detection result of said detection means. To each other who was given about one of an amendment means to amend said detection result using said amendment information, and the arbitration of two or more of said detection shaft orientations, each sense and magnitude of the amount of dynamics of the reverse sense, Each sense and magnitude of the amount of dynamics given about each of detection shaft orientations other than these detection shaft orientations, The amount detector of dynamics characterized by having an amendment information generation means to generate said amendment information based on relation with each detection result of said detection means when said each amount of dynamics is given, and to memorize this for said storage means.

[Claim 2] It is the amount detector of dynamics characterized by being biaxial or three shafts with which said two or more detection shafts intersect perpendicularly mutually in claim 1.

[Claim 3] It is the amount detector of dynamics characterized by detecting said amount of dynamics where said detection means is formed in an object in claim 1 or 2.

[Claim 4] A detection means to output the signal according to the amount of dynamics which is the amount detector of dynamics formed in the object, and was given. A storage means to memorize the amendment information for amending the output value of said detection means. Each sense and magnitude of the amount of dynamics of two or more sense which has known magnitude. An amendment information generation means to generate said amendment information and to memorize this for said storage means based on relation with each output value of said detection means when these amounts of dynamics are given. The amount detector of dynamics characterized by having an amendment means to amend the output value of said detection means based on said amendment information memorized by said storage means, and to output the result.

[Claim 5] It is the amount detector of dynamics characterized by said object being a body of a camera, or a lens-barrel in claim 3 or 4.

[Claim 6] It is the amount detector of dynamics characterized by said amounts of dynamics being acceleration, angular velocity, or the angular acceleration in claims 1, 2, 3, and 4 or 5.

[Claim 7] Are the amount detection approach of dynamics for detecting the amount of dynamics, and it has two or more detection shafts. If the posture of the object equipped with a detection means to detect the amount of dynamics which acts on each detection shaft orientations is changed at least 4 times and even either of said two or more detection shaft orientations attaches it The amount of dynamics of the reverse sense is given independently mutually. About each of detection shaft orientations other than this Each sense and magnitude of the amount of dynamics which gave and gave the amount of dynamics of the sense of arbitration. The amount detection approach of dynamics which is made to memorize the amendment information which generated and generated amendment information based on each detection result of said detection means at the time of giving these amounts of dynamics, and amends the detection result of said detection means based on this amendment information made to memorize.

[Claim 8] It is the amount detection approach of dynamics characterized by said amounts of dynamics being acceleration, angular velocity, or the angular acceleration in claim 7.

[Translation done.]

* NOTICES *

JP0 and NCIP1 are not responsible for any damages caused by the use of this translation.

- 1.This document has been translated by computer. So the translation may not reflect the original precisely.
- 2.*** shows the word which can not be translated.
- 3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to the amount detector of dynamics for detecting the amount of dynamics, and the amount detection approach of dynamics.

[0002]

[Description of the Prior Art] Although the camera which amends a hand deflection is developed in recent years, one or more acceleration sensors (or angular-velocity sensor) are usually installed in the interior of this camera. When the number of sensors is one, the thing of a multiple spindle was used and the acceleration of the shaft orientations concerning a camera etc. is usually detected.

[0003] Moreover, from the sensing element of a sensor, the detection result is usually outputted as electrical-potential-difference values V_x , V_y , and V_z . Therefore, it calculates like using the multipliers C_x , C_y , and C_z for which it asked beforehand and dc-component value $V_{xDC'}$, $V_{yDC'}$, and $V_{zDC'}$ to these electrical-potential-difference values (formula 1), and amount A_x of dynamics, such as acceleration, A_y , and A_z are computed. An above-mentioned multiplier and an above-mentioned dc-component value are a value of the sensor proper for which it asked before installing a sensor in a camera.

[0004]

[Equation 1]

数1

$$\begin{aligned} A_x' &= C_x (V_x - V_{xDC'}) \\ A_y' &= C_y (V_y - V_{yDC'}) \\ A_z' &= C_z (V_z - V_{zDC'}) \end{aligned} \quad - (式1)$$

[0005] Now, it is usually known by the sensor of a multiple spindle that an interferent component is in each shaft. About this, it is indicated by JP,3-276072,A and, specifically, relation as shown in (a formula 2) is known, for example. A_x , A_y , and A_z are the given amounts of dynamics, and V_x , V_y , and V_z are the output values of a sensing element. Moreover, S_{xx} , S_{xy} , S_{xz} , S_{yx} , S_{yy} , S_{yz} , S_{zx} , S_{zy} , and S_{zz} show detection sensitivity.

[0006]

[Equation 2]

数2

$$\begin{bmatrix} V_x - V_{xDC} \\ V_y - V_{yDC} \\ V_z - V_{zDC} \end{bmatrix} = \begin{bmatrix} S_{xx} & S_{xy} & S_{xz} \\ S_{yx} & S_{yy} & S_{yz} \\ S_{zx} & S_{zy} & S_{zz} \end{bmatrix} \begin{bmatrix} A_x \\ A_y \\ A_z \end{bmatrix} \quad - (式2)$$

[0007] Here, (a formula 2) is [0008].

[Equation 3]

数3

$$\begin{bmatrix} A_x \\ A_y \\ A_z \end{bmatrix} = \begin{bmatrix} S_{xx} & S_{xy} & S_{xz} \\ S_{yx} & S_{yy} & S_{yz} \\ S_{zx} & S_{zy} & S_{zz} \end{bmatrix}^{-1} \begin{bmatrix} V_x - V_{xDC} \\ V_y - V_{yDC} \\ V_z - V_{zDC} \end{bmatrix} \quad - (式3)$$

[0009] It can deform and is [0010] further.

[Equation 4]

数4

$$\begin{bmatrix} A_x \\ A_y \\ A_z \end{bmatrix} = \begin{bmatrix} C_{11} & C_{12} & C_{13} \\ C_{21} & C_{22} & C_{23} \\ C_{31} & C_{32} & C_{33} \end{bmatrix} \begin{bmatrix} V_x - V_{xDC} \\ V_y - V_{yDC} \\ V_z - V_{zDC} \end{bmatrix} \quad - (式4)$$

[0011] It can express.

[0012] In addition, a coefficient $C_{11} - C_{33}$ are detection sensitivity $S_{xx} - S_{zz}$. It is an inverse matrix.

[0013] And it is [0014] when (a formula 4) is made into a general formula.

[Equation 5]

$$\begin{aligned}
 \text{数5} \quad & A_x = C11 (V_x - V_{xDC}) + C12 (V_y - V_{yDC}) + C13 (V_z - V_{zDC}) \\
 & A_y = C21 (V_x - V_{xDC}) + C22 (V_y - V_{yDC}) + C23 (V_z - V_{zDC}) \\
 & A_z = C31 (V_x - V_{xDC}) + C32 (V_y - V_{yDC}) + C33 (V_z - V_{zDC})
 \end{aligned}$$

- (式5)

[0015] It becomes. That is, if (a formula 5) is used, the amounts A_x , A_y , and A_z of dynamics by which the interferent component of each shaft was amended can be calculated.

[0016]

[Problem(s) to be Solved by the Invention] However, there are the following problems also in any of the conventional example mentioned above.

[0017] That is, in these conventional examples, the amount of dynamics detected before installing a sensor in a camera, and the amount of dynamics detected after installing a sensor in a camera will cross. The straight line 2 of drawing 5 shows the relation between the output of the sensor before camera installation, and the amount of dynamics calculated from now on, and a straight line 1 shows the relation between the output of the sensor after camera installation, and the amount of dynamics calculated from now on.

[0018] It is a mutual gap of straight lines 1 and 2, i.e., a detection error, and this is based on the installation error mainly produced in case a sensor is installed in a camera. When there is an installation error, the above-mentioned multiplier and above-mentioned dc-component value which were calculated before camera installation stop making semantics.

[0019] Of course, that an installation error should be canceled, although installation precision of a sensor may be made severe, there is a trouble that cost becomes high in this case.

[0020] In addition, although the detection sensitivity and the dc-component value which were calculated before camera installation may be used as it is when attaching a sensor in the object which seldom asks an installation error instead of a precision instrument like a camera, detection sensitivity and a dc-component value have a demand of wanting to ask simply, even in this case.

[0021] The 1st purpose of this invention is in consideration of the above trouble to offer the amount detector of dynamics with a high detection precision, and the amount detection approach of dynamics. The 2nd purpose of this invention is to offer the amount detector of dynamics and the amount detection approach of dynamics of searching for the amendment information concerning detection precision easily.

[0022]

[Means for Solving the Problem] A detection means to detect the amount of dynamics which according to the 1st mode of this invention for attaining the above-mentioned purpose has two or more detection shafts and acts on each detection shaft orientations, A storage means to memorize the amendment information for amending the detection result of said detection means, To each other who was given about one of an amendment means to amend said detection result using said amendment information, and the arbitration of two or more of said detection shaft orientations, each sense and magnitude of the amount of dynamics of the reverse sense, Each sense and magnitude of the amount of dynamics given about each of detection shaft orientations other than these detection shaft orientations, Said amendment information is generated based on relation with each detection result of said detection means when said each amount of dynamics is given, and the amount detector of dynamics characterized by having an amendment information generation means to memorize this for said storage means is offered.

[0023] the 2nd voice of this invention for attaining the above-mentioned purpose — if it depends like — the 1st voice — it sets like and the amount detector of dynamics characterized by said two or more detection shafts being biaxial or three shafts which intersect perpendicularly mutually is offered.

[0024] According to the 3rd mode of this invention for attaining the above-mentioned purpose, in the 1st or 2nd mode, the amount detector of dynamics characterized by said detection means detecting said amount of dynamics in the condition of having been prepared in the object is offered.

[0025] A detection means to output the signal according to the amount of dynamics which according to the 4th mode of this invention for attaining the above-mentioned purpose is the amount detector of dynamics formed in the object, and was given, A storage means to memorize the amendment information for amending the output value of said detection means, Each sense and magnitude of the amount of dynamics of two or more sense which has known magnitude, An amendment information generation means to generate said amendment information and to memorize this for said storage means based on relation with each output value of said detection means when these amounts of dynamics are given, The output value of said detection means is amended based on said amendment information memorized by said storage means, and the amount detector of dynamics characterized by having an amendment means to output the result is offered.

[0026] According to the 5th mode of this invention for attaining the above-mentioned purpose, in the 3rd or 4th mode, the amount detector of dynamics characterized by said object being a body of a camera or a lens-barrel is offered.

[0027] According to the 6th mode of this invention for attaining the above-mentioned purpose, in the 1st, the 2nd, the 3rd, the 4th, or the 5th, the amount detector of dynamics characterized by said amounts of dynamics being acceleration, angular velocity, or the angular acceleration is offered.

[0028] According to the 7th mode of this invention for attaining the above-mentioned purpose, it is the amount detection approach of dynamics for detecting the amount of dynamics. If it has two or more detection shafts,

the posture of the object equipped with a detection means to detect the amount of dynamics which acts on each detection shaft orientations is changed at least 4 times and even either of said two or more detection shaft orientations is attached. The amount of dynamics of the reverse sense is given independently mutually. About each of detection shaft orientations other than this. Each sense and magnitude of the amount of dynamics which gave and gave the amount of dynamics of the sense of arbitration. The amendment information which generated and generated amendment information based on each detection result of said detection means at the time of giving these amounts of dynamics is made to memorize, and the amount detection approach of dynamics which amends the detection result of said detection means is offered based on this amendment information made to memorize.

[0029] According to the 8th mode of this invention for attaining the above-mentioned purpose, in the 7th mode, the amount detection approach of dynamics characterized by said amounts of dynamics being acceleration, angular velocity, or the angular acceleration is offered.

[0030]

[Function] According to the 1st mode of this invention, the detection means has two or more detection shafts, and detects the amount of dynamics which acts on each detection shaft orientations. A storage means memorizes the amendment information for amending the detection result of a detection means. An amendment means amends said detection result using this amendment information. In addition, amendment information is generated by the amendment information generation means.

[0031] Moreover, two or more detection shafts may be three shafts (it considers as a x axis, the y-axis, and the z-axis hereafter) which intersect perpendicularly mutually like the 2nd mode. in this case — for example, the amendment information generation means was given about one of the arbitration of two or more detection shaft orientations (for example, the direction of a x axis) — with each sense and magnitude of the amount of dynamics of the reverse sense mutually. Based on the relation between each sense and magnitude of the given amount of dynamics, and each detection result of said detection means when said each amount of dynamics is given, said amendment information is generated about each (the direction of the y-axis, the direction of the z-axis) of detection shaft orientations other than these detection shaft orientations. In the case of for example, the direction of a x axis, the sense of the amount of dynamics is equivalent to forward [of a x axis], or negative sense, and is specifically expressed as a sign. The magnitude of the amount of dynamics is the absolute value of the amount of dynamics.

[0032] In addition, in this example, since every one amounts [four] of dynamics in all are given [direction / of a x axis] about each of two, the direction of the y-axis, and the direction of the z-axis, a detection result is set to four. Moreover, in order that a detection means may detect the amount of dynamics which acts on each detection shaft orientations, the detection information about the direction of a x axis, the detection information about the direction of the y-axis, and all the detection information about the direction of the z-axis are included in each of these four detection results.

[0033] As mentioned above, in this example, amendment information is generable only by giving the four above-mentioned amounts of dynamics.

[0034] In addition, a detection means can also detect the amount of dynamics in the condition of having been prepared in the object, like the 3rd mode.

[0035] According to the 4th mode of this invention, a detection means outputs the signal according to the given amount of dynamics. A storage means memorizes the amendment information for amending the output value of a detection means. Based on the relation between each sense and magnitude of the amount of dynamics of two or more sense which has known magnitude, and each output value of said detection means when these amounts of dynamics are given, an amendment information generation means generates said amendment information, and memorizes this for said storage means. An amendment means amends the output value of a detection means based on the amendment information memorized by the storage means, and outputs the result.

[0036] In addition, if sequential change of the posture of an object is carried out when treating acceleration as an amount of dynamics, gravitational acceleration can be used as an amount of dynamics of two or more sense which has known magnitude. The body of a camera and a lens-barrel are sufficient as an object, and these postures can be changed simply.

[0037] Moreover, if amendment information is generated in the condition of having been prepared in the target object, like the 3rd and 4th mode, before being installed in an object, the detection precision will improve as compared with the former which searches for amendment information.

[0038] According to the 6th mode, it has two or more detection shafts, and amendment information can be generated only by changing the posture of the object equipped with a detection means to detect the amount of dynamics which acts on each detection shaft orientations, at least 4 times.

[0039] In addition, the amount of dynamics of the 1st – the 6th mode may be others, angular velocity, or angular acceleration. [acceleration]

[0040]

[Example] Hereafter, one example of this invention is explained using a drawing.

[0041] Four postures of a camera 11 in which the amount detector 12 of dynamics of this example was carried are shown in drawing 1 (a) – drawing 1 (d), and gravity acts on the sense of an arrow head A, respectively. The amount detector 12 of dynamics has a detecting element 21, the amendment information generation section 22, and the amendment section 23, as shown in drawing 2. In this example, the sensing element (for example, semiconductor device using a piezoresistance condenser) which detects the acceleration of x and y which

intersect perpendicularly mutually, and each axial component of the z-axis to a detecting element 21, and outputs each detection result to it as an electrical-potential-difference value is used. The amendment information generation section 22 and the amendment section 23 have CPU and the storage section (only the storage section 24 is illustrated), and are constituted, and the program which is needed in case the operation which mentions later is performed by CPU is memorized by each storage section. Moreover, the detecting element 21 is formed in the flexible section from which it bends according to the given acceleration, and an amount changes. Although this flexible section is not illustrated especially since it is generally used to the amount detectors of dynamics, such as an acceleration sensor, it is manufacturing the silicon substrate by keeping winding to a concave by etching processing at this example. In addition, if the amendment information generation section 22 and the amendment section 23 are also collectively manufactured to the silicon substrate in which the flexible section is formed, it not only can attain the miniaturization of the amount detector of dynamics, but it can reduce wiring resistance.

[0042] Drawing 1 (a) is in the condition which made positive sense of a x axis all over drawing and a top. At this time, a sensing element detects the following acceleration in each shaft orientations theoretically.

[0043]

[Equation 6]

数6

$$A_x = G, A_y = 0, A_z = 0$$

- (式6)

[0044] In case acceleration G: of the acceleration A_z :z shaft orientations of the acceleration A_y :y shaft orientations of A_x :x shaft orientations installs gravitational acceleration, however a sensing element in a camera, since an installation error arises, generally the component of other shafts will be contained in the component of one shaft. Therefore, the detection error is included in the output voltage of the sensing element at this time. Now, this output voltage is set to V_{xxu} , V_{yxu} , and $V_{z xu}$. V_{xxu} , V_{yxu} , and $V_{z xu}$ support the x-axis output, the y-axis output, and the z-axis output in order.

[0045] Drawing 1 (b) is in the condition which made positive sense of a x axis all over drawing and the bottom. At this time, a sensing element detects the following acceleration in each shaft orientations theoretically.

[0046]

[Equation 7]

数7

$$A_x = -G, A_y = 0, A_z = 0$$

- (式7)

[0047] In addition, output voltage of the sensing element at this time is set to V_{xxd} , V_{yxd} , and V_{zxd} . The detection error is included in such output voltage like the above-mentioned.

[0048] Moreover, drawing 1 (c) is in the condition which turned the positive sense of the y-axis up. The acceleration on the theory which a sensing element detects at this time is [0049].

[Equation 8]

数8

$$A_x = 0, A_y = G, A_z = 0$$

- (式8)

[0050] It comes out, and it is and output voltage at this time is set to V_{xyu} , V_{yyu} , and V_{zyu} .

[0051] Moreover, drawing 1 (d) is in the condition which turned the positive sense of the z-axis up. The acceleration on the theory which a sensing element detects at this time is [0052].

[Equation 9]

数9

$$A_x = 0, A_y = 0, A_z = G$$

- (式9)

[0053] It comes out, and it is and output voltage at this time is set to V_{xzu} , V_{yzu} , and $V_{z zu}$.

[0054] And three equations obtained because the amendment information generation section 22 substitutes $A_x=G$, $A_y=0$, $A_z=0$ and $V_x=V_{xxu}$, $V_y=V_{yxu}$, and $V_z=V_{z xu}$ for (an equation 2), Three equations obtained by substituting $A_x=-G$, $A_y=0$, $A_z=0$ and $V_x=V_{xxd}$, $V_y=V_{yxd}$, and $V_z=V_{zxd}$ for (an equation 2), Three equations obtained by substituting $A_x=0$, $A_y=G$, $A_z=0$ and $V_x=V_{xyu}$, $V_y=V_{yyu}$, and $V_z=V_{zyu}$ for (an equation 2), By solving the simultaneous equations of 12 which consists of three equations obtained by substituting $A_x=0$, $A_y=0$, $A_z=G$ and $V_x=V_{xzu}$, $V_y=V_{yzu}$, and $V_z=V_{z zu}$ for (an equation 2) The detection sensitivity S_{xx} , S_{xy} , S_{xz} , S_{yx} , S_{yy} , S_{yz} , S_{zx} , S_{zy} , and S_{zz} , V_{xDC} (dc component of a x axis) and V_{yDC} (dc component of the y-axis), and V_{zDC} (dc component of the z-axis) are computed. These values are as being shown in (a formula 10) and (a formula 11), and are memorized by the storage section 24 of the amendment information generation section 22. In addition, this operation is carried out before performing actual acceleration detection.

[0055]

[Equation 10]

数10

$$V_{xDC} = (V_{xxu} + V_{xxd}) / 2$$

$$V_{yDC} = (V_{yxu} + V_{yxd}) / 2$$

$$V_{zDC} = (V_{z xu} + V_{zxd}) / 2$$

- (式10)

[0056]

[Equation 11]

数11)

$$S_{xx} = (V_{xu} - V_{DC}) / G$$

$$S_{xy} = (V_{yu} - V_{DC}) / G$$

$$S_{xz} = (V_{zu} - V_{DC}) / G$$

$$S_{yx} = (V_{xu} - V_{DC}) / G$$

$$S_{yy} = (V_{yu} - V_{DC}) / G$$

$$S_{yz} = (V_{zu} - V_{DC}) / G$$

$$S_{zx} = (V_{xu} - V_{DC}) / G$$

$$S_{zy} = (V_{yu} - V_{DC}) / G$$

$$S_{zz} = (V_{zu} - V_{DC}) / G$$

- (式11)

[0057] and in actually performing acceleration detection, the detection sensitivity and the dc-component value which calculated each electrical-potential-difference values V_x , V_y , and V_z outputted from the sensing element in the amendment information generation section 22 for each of these electrical-potential-difference values reception and after that set up the amendment section 23 first — having had (or (formula 3) (formula 4)) — it uses and changes into A_x , A_y , and A_z . Under the present circumstances, while each electrical-potential-difference value is changed into acceleration, the interferent component of each shaft will also be amended.

[0058] As shown in drawing 3 and drawing 4, as compared with the case where this processing is not performed, detection precision of acceleration obtained by this transform processing improves.

[0059] When it explains concretely, the data (namely, data at the time of changing a sensor output into acceleration by (the formula 1)) when not performing the above-mentioned transform processing are shown in drawing 3 (a), for example, a single-tier eye is as a result of [of each shaft at the time of giving the acceleration of 1G in the direction of a x axis] detection. Similarly, eye two trains is as a result of [of each shaft at the time of giving the acceleration of 1G in the direction of the y-axis] detection, and a triplex-row eye is as a result of [of each shaft at the time of giving the acceleration of 1G in the direction of the z-axis] detection.

[0060] On the other hand, the data at the time of performing the above-mentioned transform processing are shown in drawing 3 (b), and a single-tier eye is like the above-mentioned as a result of [of each shaft at the time of giving the acceleration of 1G in the direction of a x axis] detection. Moreover, eye two trains is as a result of [when a triplex-row eye gives the acceleration of 1G in the direction of the y-axis in the direction of the z-axis] detection.

[0061] The detection precision of data at the time of performing transform processing is improving rather than the data when not performing transform processing, and these differences are more notably expressed to drawing 4 (a) and (b) so that drawing 3 (a) and (b) may also show. Drawing 4 (a) and (b) show the rate of the interferent component of other shafts to the detection result of the shaft which gave acceleration. For example, in the single-tier eye of drawing 3 (b), the interferent components of the y-axis and the Z-axis to the detection result of a x axis are (0.0012/9.8147) and (0.0007/9.8147), respectively, and these are indicated by the single-tier eye of drawing 4 (b).

[0062] On the whole in this experiment, the rate of an interferent component and the so-called cross talk were able to be reduced about triple figures so that it might understand, even if it saw drawing 4 (a) and (b).

[0063] According to this example, detection sensitivity and a dc-component value can be easily calculated only by changing the posture of a camera 4 times like drawing 1 as mentioned above. Moreover, since these operations are performed after the amount detector of dynamics is installed in a camera, the exact amount operation of dynamics unrelated to an installation error can be carried out. That is, as compared with the former which must install the amount detector of dynamics with a sufficient precision in a camera, installation becomes easy and working hours are shortened sharply.

[0064] In addition, if it is not necessarily limited to drawing 1 and even the direction of a x axis, the direction of the y-axis, or the directions of the z-axis are attached, change of the posture of a camera gives the acceleration of the reverse sense independently mutually, and if the acceleration of the sense of arbitration is given, it can calculate detection sensitivity and a dc-component value about each of detection shaft orientations other than this. In addition, to give acceleration, without being based on three shafts of drawing 1, it is necessary to grasp beforehand the magnitude and the sense of an acceleration component of 3 shaft orientations at the time of giving each acceleration.

[0065] You may carry out using the equipment of dedication at the time of shipment adjustment of a camera, and may make it carry out to the user of a camera about posture change. In this case, for example, the 4th page (in the case of drawing 1, they are the both-sides side of a camera body, an inferior surface of tongue, and a tooth back) which intersects perpendicularly with some camera bodies is formed beforehand. A user can realize posture change as shows these fields to drawing 1 by doubling with an even table etc. one by one.

[0066] In addition, the acceleration given to a camera could be given using the equipment which is not necessarily limited to gravitational acceleration, for example, gives acceleration compulsorily. Moreover, when using an angular-velocity sensor, equipment equipped with the rotary table for laying a camera may be used.

[0067] Moreover, the lens-barrel of a camera is sufficient as the object with which the amount detector 12 of

dynamics is installed. Of course, the amount detector 12 of dynamics is applicable to various objects other than a camera. In addition, the amount of dynamics to detect should just choose any of acceleration, angular velocity, the angular acceleration, etc. they are according to an object.

[0068] Moreover, the configuration that it prepares independently, without installing the amendment information generation section 22 in a camera, each output of the sensing element when changing four postures is read here, detection sensitivity and a dc-component value are calculated like the above-mentioned, and the storage section in a camera is made to memorize the result may be used.

[0069] Moreover, the directions from a user may be received, and you may constitute so that above-mentioned detection sensitivity and an above-mentioned dc-component value can be calculated at any time. The effectiveness of the amendment reduces detection sensitivity and a dc-component value according to secular change of a sensing element etc. Therefore, if it enables it to calculate these values at any time, an always accurate detection result can be obtained.

[0070] In addition, in the case of the object (that is, detection precision may be low) which does not ask an installation error etc., before installing the amount detector of dynamics in an object, detection sensitivity and a dc-component value may be calculated, but detection sensitivity and a dc-component value can be easily calculated even in this case by carrying out posture change of the amount detector of dynamics like the above-mentioned.

[0071]

[Effect of the Invention] According to this invention, the amendment information for amending the detection result of a detection means can be searched for easily. Moreover, since amendment information is searched for after a detection means is installed in an object, detection precision improves.

[0072]

[Translation done.]

*** NOTICES ***

JPO and NCIPJ are not responsible for any damages caused by the use of this translation.

- 1.This document has been translated by computer. So the translation may not reflect the original precisely.
- 2.*** shows the word which can not be translated.
- 3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The explanatory view showing four postures of a camera in which one example of the amount detector of dynamics concerning this invention was carried.

[Drawing 2] The block diagram showing the configuration of one example of the amount detector of dynamics concerning this invention.

[Drawing 3] **Drawing 3 (a):** The graph showing the output of each shaft of the conventional amount detector of dynamics.

Drawing 3 (b): The graph showing the output of each shaft of one example of the amount detector of dynamics concerning this invention.

[Drawing 4] **Drawing 4 (a):** The graph showing the interferent component of each shaft of the conventional amount detector of dynamics.

Drawing 4 (b): The graph showing the interferent component of each shaft of one example of the amount detector of dynamics concerning this invention.

[Drawing 5] The explanatory view showing the relation of the output of the amount detector of dynamics and the amount of dynamics before camera installation, and the relation of the output of the amount detector of dynamics and the amount of dynamics after camera installation.

[Description of Notations]

11: Camera 12: The amount detector of dynamics 21: Detecting element 22: Amendment information generation section 23: Amendment section 24: Storage section

[Translation done.]

(19)日本国特許庁 (J P)

(12) 公開特許公報 (A)

(11)特許出願公開番号

特開平8-304448

(43)公開日 平成8年(1996)11月22日

(51)IntCl ⁸	識別記号	庁内整理番号	F I	技術表示箇所
G 0 1 P 15/12			G 0 1 P 15/12	
G 0 1 L 1/16			G 0 1 L 1/16	
G 0 1 P 21/00			G 0 1 P 21/00	

審査請求 未請求 請求項の数8 OL (全 8 頁)

(21)出願番号	特願平7-113338	(71)出願人	000004112 株式会社ニコン 東京都千代田区丸の内3丁目2番3号
(22)出願日	平成7年(1995)5月11日	(72)発明者	原 信也 東京都千代田区丸の内3丁目2番3号 株式会社ニコン内
		(72)発明者	岡崎 光宏 東京都千代田区丸の内3丁目2番3号 株式会社ニコン内
		(74)代理人	弁理士 三品 岩男 (外1名)

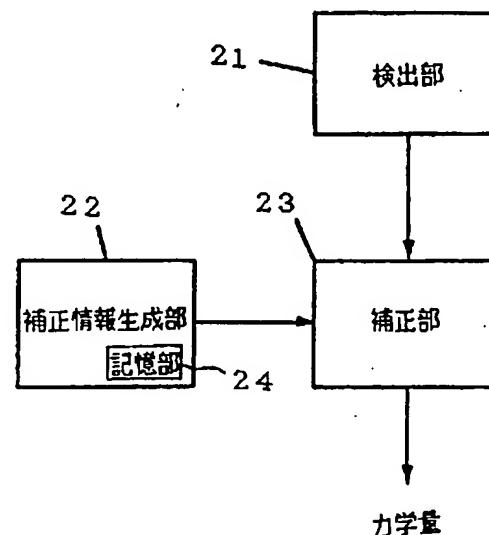
(54)【発明の名称】 力学量検出器および力学量検出方法

(57)【要約】

【目的】検出精度に係る補正情報を簡単に求めることができる力学量検出器および力学量検出方法を提供する。

【構成】複数の検出軸を有し、各検出軸方向に作用する力学量を検出する検出部21と、検出部21の検出結果を補正するための補正情報を記憶する記憶部24と、補正情報を用いて前記検出結果を補正する補正部23と、前記複数の検出軸方向の任意の一つについて与えられた、互いに逆向きの力学量のそれぞれの向き及び大きさと、この検出軸方向以外の検出軸方向のそれぞれについて与えられた力学量のそれぞれの向き及び大きさと、前記各力学量が与えられたときの検出部21の各検出結果との関係に基づいて前記補正情報を生成し、これを記憶部24に記憶する補正情報生成部22とを有する。

図2



【特許請求の範囲】

【請求項1】複数の検出軸を有し、各検出軸方向に作用する力学量を検出する検出手段と、

前記検出手段の検出結果を補正するための補正情報を記憶する記憶手段と、

前記補正情報を用いて前記検出結果を補正する補正手段と、

前記複数の検出軸方向の任意の一つについて与えられた、互いに逆向きの力学量のそれぞれの向き及び大きさと、この検出軸方向以外の検出軸方向のそれぞれについて与えられた力学量のそれぞれの向き及び大きさと、前記各力学量を与えられたときの前記検出手段の各検出結果との関係に基づいて前記補正情報を生成し、これを前記記憶手段に記憶する補正情報生成手段とを有することを特徴とする力学量検出器。

【請求項2】請求項1において、前記複数の検出軸は、互いに直交する2軸又は3軸であることを特徴とする力学量検出器。

【請求項3】請求項1又は2において、前記検出手段は、対象物に設けられた状態で前記力学量を検出することを特徴とする力学量検出器。

【請求項4】対象物に設けられた力学量検出器であって、与えられた力学量に応じた信号を出力する検出手段と、前記検出手段の出力値を補正するための補正情報を記憶する記憶手段と、

既知の大きさを有する複数の向きの力学量のそれぞれの向き及び大きさと、これらの力学量を与えられた場合の前記検出手段の各出力値との関係に基づいて、前記補正情報を生成し、これを前記記憶手段に記憶する補正情報生成手段と、

前記記憶手段に記憶された前記補正情報をもとに前記検出手段の出力値を補正し、その結果を出力する補正手段とを有することを特徴とする力学量検出器。

【請求項5】請求項3又は4において、前記対象物は、カメラ本体又は鏡筒であることを特徴とする力学量検出器。

【請求項6】請求項1、2、3、4、又は5において、*

数1

$$\begin{aligned} Ax' &= Cx (Vx - VxDC') \\ Ay' &= Cy (Vy - VyDC') \\ Az' &= Cz (Vz - VzDC') \end{aligned}$$

【0005】さて、多軸のセンサには、普通、各軸に干渉成分があることが知られている。これについては、例えば、特開平3-276072号公報にも記載されており、具体的には、(式2)に示すような関係が知られている。Ax、Ay、Azは、与えられた力学量であり、V ※

数2

$$\begin{bmatrix} Vx - VxDC' \\ Vy - VyDC' \\ Vz - VzDC' \end{bmatrix} = \begin{bmatrix} Sxx & Sxy & Sxz \\ Syx & Syy & Syz \\ Szx & Szy & Szz \end{bmatrix} \begin{bmatrix} Ax \\ Ay \\ Az \end{bmatrix}$$

-(式2)

* 前記力学量は、加速度、角速度、及び、角加速度のうちのいずれかであることを特徴とする力学量検出器。

【請求項7】力学量を検出するための力学量検出方法であって、

複数の検出軸を有し、各検出軸方向に作用する力学量を検出する検出手段を備えた対象物の姿勢を少なくとも4回変化させ、前記複数の検出軸方向の何れか一つについては、互いに逆向きの力学量を独立に与え、これ以外の検出軸方向のそれぞれについては、任意の向きの力学量を与え、与えた力学量のそれぞれの向き及び大きさと、これらの力学量を与えた際の前記検出手段の各検出結果に基づいて補正情報を生成し、生成した補正情報を記憶させ、この記憶させた補正情報を基に、前記検出手段の検出結果を補正する力学量検出方法。

【請求項8】請求項7において、前記力学量は、加速度、角速度、及び、角加速度のうちのいずれかであることを特徴とする力学量検出方法。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は、力学量を検出するための力学量検出器および力学量検出方法に関する。

【0002】

【従来の技術】近年、手振れを補正するカメラが開発されているが、このカメラの内部には、普通、一つ又は複数の加速度センサ（又は角速度センサ）が設置されている。センサが一つの場合は、通常、多軸のものを使用し、カメラにかかる軸方向の加速度等を検出している。

【0003】また、センサの検出素子からは、普通、その検出結果が電圧値Vx、Vy、Vzとして出力される。

したがって、これらの電圧値に対して、予め求めておいた係数Cx、Cy、Czおよび直流成分値VxDC'、VyDC'、VzDC'を用いて(式1)の如く計算を行い、加速度などの力学量Ax'、Ay'、Az'を算出する。前述の係数および直流成分値は、センサをカメラに設置する前に求めたセンサ固有の値である。

【0004】

【数1】

-(式1)

※x、Vy、Vzは、検出素子の出力値である。また、Sxx、Sxy、Sxz、Syy、Syz、Szz、Szy、Szzは、検出感度係数を示している。

【0006】

【数2】

【0007】ここで、(式2)は、
【0008】

*【数3】

*

数3

$$\begin{bmatrix} A_x \\ A_y \\ A_z \end{bmatrix} = \begin{bmatrix} S_{xx} & S_{xy} & S_{xz} \\ S_{yx} & S_{yy} & S_{yz} \\ S_{zx} & S_{zy} & S_{zz} \end{bmatrix}^{-1} \begin{bmatrix} V_x - V_{xDC} \\ V_y - V_{yDC} \\ V_z - V_{zDC} \end{bmatrix}$$

-(式3)

【0009】と変形でき、さらに、
【0010】

※【数4】

※

数4

$$\begin{bmatrix} A_x \\ A_y \\ A_z \end{bmatrix} = \begin{bmatrix} C_{11} & C_{12} & C_{13} \\ C_{21} & C_{22} & C_{23} \\ C_{31} & C_{32} & C_{33} \end{bmatrix} \begin{bmatrix} V_x - V_{xDC} \\ V_y - V_{yDC} \\ V_z - V_{zDC} \end{bmatrix}$$

-(式4)

【0011】と表すことができる。

★【0013】そして、(式4)を一般式にすると、

【0012】なお、係数C11~C33は、検出感度係数S
xx~Szzの逆行列である。

【0014】

★【数5】

数5

$$A_x = C_{11}(V_x - V_{xDC}) + C_{12}(V_y - V_{yDC}) + C_{13}(V_z - V_{zDC})$$

$$A_y = C_{21}(V_x - V_{xDC}) + C_{22}(V_y - V_{yDC}) + C_{23}(V_z - V_{zDC})$$

$$A_z = C_{31}(V_x - V_{xDC}) + C_{32}(V_y - V_{yDC}) + C_{33}(V_z - V_{zDC})$$

-(式5)

【0015】となる。すなわち、(式5)を利用すれば、各軸の干渉成分が補正された力学量Ax、Ay、Azを求めることができる。

【0016】

【発明が解決しようとする課題】しかしながら、前述した従来例の何れにおいても、以下のような問題がある。

【0017】すなわち、これらの従来例では、センサをカメラに設置する前に検出した力学量と、センサをカメラに設置した後に検出した力学量とが、くい違ってしまふ。図5の直線2は、カメラ設置前における、センサの出力と、これから求めた力学量との関係を示したものであり、直線1は、カメラ設置後における、センサの出力と、これから求めた力学量との関係を示したものである。

【0018】直線1、2の相互のずれは、即ち検出誤差であり、これは主に、センサをカメラに設置する際に生じる設置誤差によるものである。設置誤差がある場合、カメラ設置前に求めておいた前述の係数および直流成分値は意味をなさなくなる。

【0019】もちろん、設置誤差を解消すべく、センサの取り付け精度を厳しくしてもよいが、この場合はコストが高くなるという問題点がある。

【0020】なお、カメラのような精密器機でなく、設置誤差をあまり問わない対象物にセンサを取り付ける場合には、カメラ設置前に求めた検出感度係数や直流成分値をそのまま用いても構わないが、この場合でも、検出感度係数や直流成分値は、簡単に求めたいという要求がある。

【0021】以上の問題点を考慮し、本発明の第1の目的は、検出精度の高い力学量検出器および力学量検出方法を提供することにある。本発明の第2の目的は、検出

20 精度に係る補正情報を簡単に求めることができる力学量検出器および力学量検出方法を提供することにある。

【0022】

【問題点を解決するための手段】上記目的を達成するための本発明の第1の態様によれば、複数の検出軸を有し、各検出軸方向に作用する力学量を検出する検出手段と、前記検出手段の検出結果を補正するための補正情報を記憶する記憶手段と、前記補正情報を用いて前記検出結果を補正する補正手段と、前記複数の検出軸方向の任意の一つについて与えられた、互いに逆向きの力学量のそれぞれの向き及び大きさと、この検出軸方向以外の検出軸方向のそれぞれについて与えられた力学量のそれぞれの向き及び大きさと、前記各力学量が与えられたときの前記検出手段の各検出結果との関係に基づいて前記補正情報を生成し、これを前記記憶手段に記憶する補正情報生成手段とを有することを特徴とする力学量検出器が提供される。

【0023】上記目的を達成するための本発明の第2の態様によれば、第1の態様において、前記複数の検出軸は、互いに直交する2軸又は3軸であることを特徴とする力学量検出器が提供される。

【0024】上記目的を達成するための本発明の第3の態様によれば、第1又は第2の態様において、前記検出手段は、対象物に設けられた状態で前記力学量を検出することを特徴とする力学量検出器が提供される。

【0025】上記目的を達成するための本発明の第4の態様によれば、対象物に設けられた力学量検出器であって、与えられた力学量に応じた信号を出力する検出手段と、前記検出手段の出力値を補正するための補正情報を記憶する記憶手段と、既知の大きさを有する複数の向きの力学量のそれぞれの向き及び大きさと、これらの力学

50

量が与えられた場合の前記検出手段の各出力値との関係に基いて、前記補正情報を生成し、これを前記記憶手段に記憶する補正情報生成手段と、前記記憶手段に記憶された前記補正情報をもとに前記検出手段の出力値を補正し、その結果を出力する補正手段とを有することを特徴とする力学量検出器が提供される。

【0026】上記目的を達成するための本発明の第5の態様によれば、第3又は第4の態様において、前記対象物は、カメラ本体又は鏡筒であることを特徴とする力学量検出器が提供される。

【0027】上記目的を達成するための本発明の第6の態様によれば、第1、第2、第3、第4、又は第5において、前記力学量は、加速度、角速度、及び、角加速度のうちのいずれかであることを特徴とする力学量検出器が提供される。

【0028】上記目的を達成するための本発明の第7の態様によれば、力学量を検出するための力学量検出方法であって、複数の検出軸を有し、各検出軸方向に作用する力学量を検出する検出手段を備えた対象物の姿勢を少なくとも4回変化させ、前記複数の検出軸方向の何れか一つについては、互いに逆向きの力学量を独立に与え、これ以外の検出軸方向のそれぞれについては、任意の向きの力学量を与え、与えた力学量のそれぞれの向き及び大きさと、これらの力学量を与えた際の前記検出手段の各検出結果に基づいて補正情報を生成し、生成した補正情報を記憶させ、この記憶させた補正情報を基に、前記検出手段の検出結果を補正する力学量検出方法が提供される。

【0029】上記目的を達成するための本発明の第8の態様によれば、第7の態様において、前記力学量は、加速度、角速度、及び、角加速度のうちのいずれかであることを特徴とする力学量検出方法が提供される。

【0030】

【作用】本発明の第1の態様によれば、検出手段は、複数の検出軸を有しており、各検出軸方向に作用する力学量を検出する。記憶手段は、検出手段の検出結果を補正するための補正情報を記憶する。補正手段は、この補正情報を用いて前記検出結果を補正する。なお、補正情報は、補正情報生成手段で生成される。

【0031】また、複数の検出軸は、第2の態様の如く、互いに直交する3軸（以下、x軸、y軸、z軸とする）であってもよい。この場合、例えば、補正情報生成手段は、複数の検出軸方向の任意の一つ（例えばx軸方向）について与えられた、互いに逆向きの力学量のそれぞれの向き及び大きさと、この検出軸方向以外の検出軸方向のそれぞれ（y軸方向、z軸方向）について与えられた力学量のそれぞれの向き及び大きさと、前記各力学量が与えられたときの前記検出手段の各検出結果との関係に基づいて前記補正情報を生成する。力学量の向きとは、例えば、x軸方向の場合、x軸の正または負の向き

に相当するもので、具体的には符号として表現される。力学量の大きさは、その力学量の絶対値である。

【0032】なお、この例では、x軸方向について2つ、y軸方向、z軸方向のそれぞれについて1つずつ、合わせて4つの力学量が与えられるので、検出結果は4つとなる。また、検出手段は、各検出軸方向に作用する力学量を検出するため、これら4つの検出結果のそれぞれには、x軸方向に関する検出情報、y軸方向に関する検出情報、z軸方向に関する検出情報のすべてが含まれている。

【0033】以上のように、本例では、前述の4つの力学量を与えるだけで補正情報を生成することができる。

【0034】なお、検出手段は、第3の態様のように、対象物に設けられた状態で力学量を検出することもできる。

【0035】本発明の第4の態様によれば、検出手段は、与えられた力学量に応じた信号を出力する。記憶手段は、検出手段の出力値を補正するための補正情報を記憶する。補正情報生成手段は、既知の大きさを有する複数の向きの力学量のそれぞれの向き及び大きさと、これらの力学量が与えられた場合の前記検出手段の各出力値との関係に基いて、前記補正情報を生成し、これを前記記憶手段に記憶する。補正手段は、記憶手段に記憶された補正情報をもとに検出手段の出力値を補正し、その結果を出力する。

【0036】なお、力学量として加速度を扱う場合に、対象物の姿勢を順次変化させれば、既知の大きさを有する複数の向きの力学量として、重力加速度を用いることができる。対象物は、カメラ本体や鏡筒でもよく、これらの姿勢は、簡単に変化させることができる。

【0037】また、第3、第4の態様のように、目的の対象物に設けられた状態で補正情報を生成すれば、対象物に設置される前に補正情報を求める従来と比較して、その検出精度が向上する。

【0038】第6の態様によれば、複数の検出軸を有し、各検出軸方向に作用する力学量を検出する検出手段を備えた対象物の姿勢を少なくとも4回変化させるだけで、補正情報を生成することができる。

【0039】なお、第1～第6の態様の力学量は、加速度のほか、角速度、または角加速度であってもよい。

【0040】

【実施例】以下、本発明の一実施例について図面を用いて説明する。

【0041】図1(a)～図1(d)には、本実施例の力学量検出器12を搭載したカメラ11の4姿勢が示されており、重力はそれぞれ矢印Aの向きに作用する。力学量検出器12は、図2に示すように、検出部21、補正情報生成部22、補正部23を有する。本実施例では、検出部21に、互いに直交するx、y、z軸の各軸成分の加速度を検出してそれぞれの検出結果を電圧値と

して出力する検出素子（例えばヒエソ抵抗効果を利用した半導体素子）を用いている。補正情報生成部22、補正部23は、例えば、CPUや記憶部（記憶部24のみ図示されている）を有して構成され、各記憶部には、後述する演算をCPUで実行する際に必要となるプログラム等が記憶されている。また、検出部21は、与えられた加速度に応じて検出量が変化する可換部に形成されている。この可換部は、加速度センサ等の力学量検出器に一般的に用いられるので特に図示しないが、本実施例ではシリコン基板をエッチング処理で凹型に繰り抜くこと*10

数6

$$Ax = G, Ay = 0, Az = 0$$

- (式6)

【0044】Ax: x軸方向の加速度

Ay: y軸方向の加速度

Az: z軸方向の加速度

G: は重力加速度

しかしながら、検出素子をカメラに設置する際には、一般に、設置誤差が生じるため、一つの軸の成分に他軸の成分が含まれてしまう。したがって、このときの検出素子の出力電圧には、検出誤差が含まれている。いま、こ*20

数7

$$Ax = -G, Ay = 0, Az = 0$$

- (式7)

【0047】なお、このときの検出素子の出力電圧は、 V_{xxd} , V_{yxd} , V_{zxd} とする。これらの出力電圧には、前述と同様、検出誤差が含まれている。

【0048】また、図1(c)は、y軸の正の向きを上★

数8

$$Ax = 0, Ay = G, Az = 0$$

- (式8)

【0050】であり、このときの出力電圧は、 V_{xyu} , V_{yyu} , V_{zyu} とする。

【0051】また、図1(d)は、z軸の正の向きを上にした状態である。このとき検出素子が検出する理論上★

数9

$$Ax = 0, Ay = 0, Az = G$$

- (式9)

【0053】であり、このときの出力電圧は、 V_{xzu} , V_{yzu} , V_{zzu} とする。

【0054】そして、補正情報生成部22は、 $Ax = G$, $Ay = 0$, $Az = 0$ 、及び、 $Vx = V_{xxu}$, $Vy = V_{yxxu}$, $Vz = V_{zxxu}$ を(式2)に代入することで得られる3つの方程式と、 $Ax = -G$, $Ay = 0$, $Az = 0$ 、及び、 $Vx = V_{xxd}$, $Vy = V_{yxd}$, $Vz = V_{zxd}$ を(式2)に代入することで得られる3つの方程式と、 $Ax = 0$, $Ay = G$, $Az = 0$ 、及び、 $Vx = V_{xyu}$, $Vy = V_{yyu}$, $Vz = V_{zyu}$ を(式2)に代入することで得られる3つの方程式と、 $Ax = 0$, $Ay = 0$, $Az = G$ 、及び、 $Vx = V_{xzu}$, ◆

数10

$$V_{xDC} = (V_{xxu} + V_{xxd}) / 2$$

$$V_{yDC} = (V_{yxxu} + V_{yxxd}) / 2$$

$$V_{zDC} = (V_{zxxu} + V_{zxxd}) / 2$$

- (式10)

【0056】

50 【数11】

*で製作している。なお、可換部が形成されているシリコン基板に、補正情報生成部22や補正部23も併せて製作すれば、力学量検出器の小型化が図れるだけでなく、配線抵抗を低減させることができる。

【0042】図1(a)は、x軸の正の向きを図中、上にした状態である。このとき検出素子は、理論上、各軸方向において以下のような加速度を検出する。

【0043】

【数6】

※の出力電圧を V_{xxu} , V_{yxxu} , V_{zxxu} とする。 V_{xxu} , V_{yxxu} , V_{zxxu} は、順に、x軸出力、y軸出力、z軸出力に対応している。

【0045】図1(b)は、x軸の正の向きを図中、下にした状態である。このとき検出素子は、理論上、各軸方向において以下のような加速度を検出する。

【0046】

【数7】

★にした状態である。このとき検出素子が検出する理論上の加速度は、

【0049】

【数8】

☆の加速度は、

30 【0052】

【数9】

◆ $Vy = V_{yzu}$, $Vz = V_{zzu}$ を(式2)に代入することで得られる3つの方程式から成る12の連立方程式を解くことで、検出感度係数 S_{xx} , S_{xy} , S_{xz} , S_{yx} , S_{yy} , S_{yz} , S_{zx} , S_{zy} , S_{zz} と、 V_{xDC} (x軸の直流成分)、 V_{yDC} (y軸の直流成分)、 V_{zDC} (z軸の直流成分)を算出する。これらの値は、(式10)、(式11)に示す通りであり、補正情報生成部22の記憶部24に記憶される。なお、この演算は、実際の加速度検出を行う前に実施される。

【0055】

【数10】

数11

$$\begin{aligned}
 S_{xx} &= (V_{xxu} - V_{xDC}) / G \\
 S_{xy} &= (V_{xyu} - V_{yDC}) / G \\
 S_{xz} &= (V_{xzu} - V_{zDC}) / G \\
 S_{yx} &= (V_{xyu} - V_{xDC}) / G \\
 S_{yy} &= (V_{yyu} - V_{yDC}) / G \\
 S_{yz} &= (V_{yzu} - V_{zDC}) / G \\
 S_{zx} &= (V_{xzu} - V_{xDC}) / G \\
 S_{zy} &= (V_{yzu} - V_{yDC}) / G \\
 S_{zz} &= (V_{zzu} - V_{zDC}) / G
 \end{aligned}$$

- (式11)

【0057】そして、実際に加速度検出を行う場合には、補正部23は、まず、検出素子から出力された各電圧値 V_x 、 V_y 、 V_z を受け取り、その後、これらの電圧値のそれぞれを、補正情報生成部22で求めた検出感度係数及び直流成分値が設定された(式3)(又は(式4))を用いて、 A_x 、 A_y 、 A_z に変換する。この際、各電圧値は、加速度に変換されるとともに、各軸の干渉成分も補正されることになる。

【0058】この変換処理によって得られた加速度は、図3、図4に示すように、該処理を行わない場合と比較して検出精度が向上する。

【0059】具体的に説明すると、図3(a)には、前述の変換処理を行わない場合のデータ(すなわち、センサ出力を(式1)で加速度に変換した場合のデータ)が示されており、例えば、一列目は、 x 軸方向に1Gの加速度を与えた場合の各軸の検出結果である。同様に、二列目は、 y 軸方向に1Gの加速度を与えた場合の各軸の検出結果であり、三列目は、 z 軸方向に1Gの加速度を与えた場合の各軸の検出結果である。

【0060】一方、図3(b)には、前述の変換処理を行った場合のデータが示されており、一列目は、前述と同様、 x 軸方向に1Gの加速度を与えた場合の各軸の検出結果である。また、二列目は、 y 軸方向に、三列目は、 z 軸方向に1Gの加速度を与えた場合の検出結果である。

【0061】図3(a)、(b)からもわかるように、変換処理を行った場合のデータは、変換処理を行わない場合のデータよりも、その検出精度が向上しており、これらの違いは、図4(a)、(b)に、より顕著に表されている。図4(a)、(b)は、加速度を与えた軸の検出結果に対する他軸の干渉成分の割合を示したものである。例えば、図3(b)の一列目において、 x 軸の検出結果に対する、 y 軸、 z 軸の干渉成分は、それぞれ、(0.0012/9.8147)、(0.0007/9.8147)であり、これらは、図4(b)の一列目に記載されている。

【0062】図4(a)、(b)を見てもわかるように、本実験では、干渉成分の割合、いわゆるクロストークを全体的に3桁程度低減することができた。

【0063】以上のように本実施例によれば、カメラの

姿勢を図1の如く4回変化させるだけで、検出感度係数や直流成分値を簡単に求めることができる。また、これらの演算を力学量検出器がカメラに設置された後に行っているため、設置誤差に無関係な正確な力学量演算を実施することができる。すなわち、力学量検出器を精度よくカメラに設置しなければならない従来と比較して、設置作業が簡単になり、作業時間が大幅に短縮される。

【0064】なお、カメラの姿勢の変化は、図1に限定されるわけではなく、 x 軸方向、 y 軸方向及び z 軸方向のうちの何れか一つについては、互いに逆向きの加速度を独立に与え、これ以外の検出軸方向のそれぞれについては、任意の向きの加速度を与えれば、検出感度係数や直流成分値を求めることができる。なお、図1の3軸を基準とせず加速度を与える場合には、各加速度を与えた場合の3軸方向の加速度成分の大きさと向きを予め把握する必要がある。

【0065】姿勢変化については、専用の装置を用いてカメラの出荷調整時に行ってもよいし、また、カメラのユーザに行わせてもよい。この場合は、例えば、カメラボディの一部に、直交する4面(図1の場合は、カメラボディの両側面、下面、背面)を予め形成する。ユーザは、これらの面を順次平らなテーブル等に合わせることで、図1に示すような姿勢変化を実現することができる。

【0066】なお、カメラに与える加速度は、重力加速度に限定されるわけではなく、例えば、加速度を強制的に与える装置を用いて付与されたものでもよい。また、角速度センサを用いる場合には、カメラを載置するための回転テーブルを備えた装置を使用してもよい。

【0067】また、力学量検出器12が設置される対象物は、カメラの鏡筒でもよい。もちろん、力学量検出器12は、カメラ以外の様々な対象物に適用することができる。なお、検出する力学量は、対象物に合わせて、加速度、角速度、角加速度等のうちの何れかを選択すればよい。

【0068】また、補正情報生成部22をカメラに設置せずに独立に設け、4姿勢を変化させたときの検出素子の各出力をここで読みとり、前述の如く検出感度係数及び直流成分値を計算し、その結果をカメラ内の記憶部に記憶させるような構成でもよい。

11

【0069】また、ユーザからの指示を受け付けて、前述の検出感度係数や直流成分値を随時演算できるように構成してもよい。検出感度係数や直流成分値は、検出素子等の経年変化によって、その補正の効果が低減する。したがって、これらの値を随時演算できるようにすれば、常に精度のよい検出結果を得ることができる。

【0070】なお、設置誤差等を問わない（すなわち検出精度が低くてもよい）対象物の場合には、力学量検出器を対象物に設置する前に、検出感度係数や直流成分値を求めてよいが、この場合でも、力学量検出器を前述の如く姿勢変化させることで、検出感度係数や直流成分値を簡単に求めることができる。

【0071】

【発明の効果】本発明によれば、検出手段の検出結果を補正するための補正情報を簡単に求めることができる。また、検出手段が対象物に設置された後に補正情報を求めるので検出精度が向上する。

【0072】

【図面の簡単な説明】

*

12

*【図1】本発明に係る力学量検出器の一実施例を搭載したカメラの4つの姿勢を示す説明図。

【図2】本発明に係る力学量検出器の一実施例の構成を示すブロック図。

【図3】図3(a)：従来の力学量検出器の各軸の出力を示す図表。

図3(b)：本発明に係る力学量検出器の一実施例の各軸の出力を示す図表。

【図4】図4(a)：従来の力学量検出器の各軸の干渉成分を示す図表。

図4(b)：本発明に係る力学量検出器の一実施例の各軸の干渉成分を示す図表。

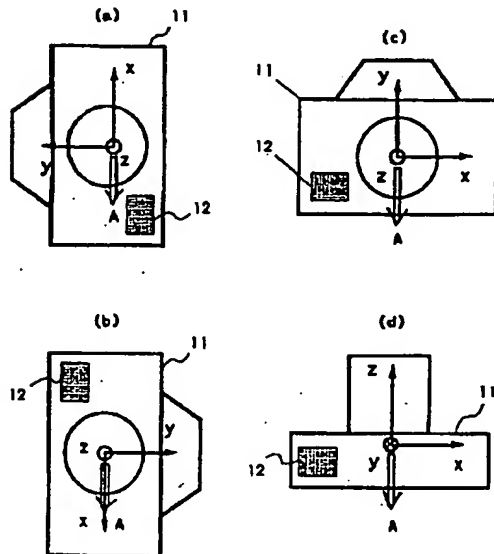
【図5】カメラ設置前における、力学量検出器の出力と力学量との関係、及び、カメラ設置後における、力学量検出器の出力と力学量との関係を示す説明図。

【符号の説明】

11：カメラ、 12：力学量検出器、 21：検出部、 22：補正情報生成部、 23：補正部、 24：記憶部

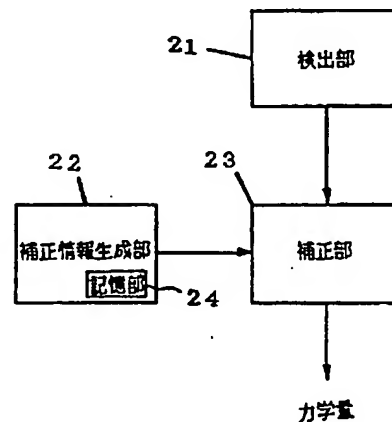
【図1】

図1



【図2】

図2



【図3】

図3

補正前の各軸出力

	x軸に1G [m/s ²]	y軸に1G [m/s ²]	z軸に1G [m/s ²]
(a) x	10.35	2.22	1.85
y	1.63	10.40	2.44
z	-1.59	1.40	10.33

補正後の各軸出力

	x軸に1G [m/s ²]	y軸に1G [m/s ²]	z軸に1G [m/s ²]
(b) x	9.8147	-0.0041	-0.0014
y	0.0012	9.8192	0.0061
z	0.0007	0.0039	9.8165

【図4】

図4

補正前の干渉成分

	x軸に対する 干渉成分 (%)	y軸に対する 干渉成分 (%)	z軸に対する 干渉成分 (%)
(a) x	-	21.8	17.9
y	15.7	-	23.6
z	-15.4	13.5	-

補正後の干渉成分

	x軸に対する 干渉成分 (%)	y軸に対する 干渉成分 (%)	z軸に対する 干渉成分 (%)
(b) x	-	-0.042	-0.014
y	0.012	-	0.052
z	0.007	0.040	-

【図5】

図5

